



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

SOME CHINESE CONTRIBUTIONS TO METEOROLOGY

By CO-CHING CHU

Before the introduction of the western sciences, meteorology in China never advanced beyond the stage of prognostication by proverbs. Although meteorological instruments had been invented (some of them preceded the western discoveries by several centuries), yet they were never made use of on a large scale, and were looked upon rather as curiosities than as instruments to be utilized for human benefit.

WEATHER PROVERBS

Weather proverbs are numerous in China, and examples may be found in the classics as well as in modern folklore. As these proverbs are based mostly on observation and experience, it is not surprising that some of them should coincide with those of the West. Thus in *Tsu-Tsz*, a blank-verse poem, written about 200-300 B. C., we have the saying, "Stay at home when the morning sky appears red, but look for a good day's travel when the evening clouds turn crimson."¹ Lao-Tze (604-?), the author of *Tao-Teh-King*,² said that heavy showers never last the whole morning, sharp thunders never last the whole day. Movement of the clouds as a prognostication of weather did not escape the notice of the early Chinese. In the writings of a scholar in the Han Dynasty, we find the saying that when clouds are going east traveling will be good, but when clouds are going west horses and carriages will be soiled. The occurrence of haloes was also believed by the Chinese to be the forerunner of a storm.

METEOROLOGICAL INSTRUMENTS

Although the use of the kite as a meteorological instrument to explore the upper air is of recent origin, yet, as a weapon of warfare, the kite was known to the Chinese at a very early date. Professor Rotch mentions³ that two hundred years after the alleged invention of a wooden dove by Archytas of Tarentum (i. e. about 200 B. C.), a Chinese general, Han Sin, employed kites as a means of communication with a garrison of a besieged town. As a matter of fact the use of kites for military operations was known in China even before the days of Archytas. In the writings of Moti,⁴ one of Confucius' most formidable rivals, who flourished between 500 and 400 B. C., mention was made.⁵ of a noted genius, Kung-Shu Pan, who spent three

¹ *Chinese Meteorol. and Astron. Mag.*, Vol. 2, 1916, p. 57, Pekin. [In Chinese.]

² This book has been translated into several European languages. Possibly the best known English translation is that of Dr. Paul Carus (Chicago, 1898).

³ A. L. Rotch: *Sounding the Ocean of Air*, New York, 1900, p. 117.

⁴ See J. W. Bashford: *China: An Interpretation*, New York, 1916, p. 186. The *Encyclopædia Britannica* (11th ed., Vol. 6, p. 226) puts Moti in the period 500-400 B. C. Professor Giles was apparently in error when he named Moti as a philosopher in the period 300-200 B. C. in his "Confucius and His Rivals."

⁵ End of Book 13.

years in constructing a bird of wood and bamboo, which when finished flew in the air for three days and three nights without apparent tendency to fall. Kung-Shu Pan constructed the bird as a device to attack the capital of Sung, one of the federal states at that time, in the interest of another state, Tsou.

Another instrument connected with meteorology and known to the early Chinese is the seismometer. Chang Hun (78-139 A. D.), who invented it, was well known in the later Han Dynasty for his literary works. His odes to Singan and Loyang were particularly celebrated. It is said that he spent ten years in writing the odes and that when they were finished the price of paper went up by leaps and bounds, showing how popular his work must have been. He seems to have been a versatile person, as he also invented several astronomical instruments and wrote an astronomical essay, Ling-Hsien, in which he expounded his theory of creation. He also calculated the value of π to be the square root of ten.⁶ The seismometer was known as "waiting wind seismometer": the significance of the term "waiting wind" is not clear. This instrument has been described and illustrated by John Milne.⁷

In Chinese history we sometimes find references to wind vanes and rain gages. We have, however, to go to Korean writings in order definitely to establish the fact that rain gages were installed for the purpose of collecting rainfall data as early as 1442 A. D.,⁸ two hundred years before Galileo's friend Benedetto Castelli introduced the use of the rain gage in the West. Dr. Wada, Director of the Korean Meteorological Service, acknowledged that the astronomical instruments of Korea were either imported from China or copied from Chinese models, but he believed that the rain gage is distinctly of Korean origin.

MAGNETIC NEEDLE

During the International Meteorological Congress held at Chicago in 1893, Bertelli, an Italian meteorologist, asserted⁹ that Christopher Columbus discovered the declination of the magnetic needle during his first transatlantic voyage. Evidences, however, tend to show that the Chinese had observed the fact of magnetic declination fully seven hundred years before Columbus. Alexander Wylie, a well-known sinologue, in his essay on the magnetic compass in China,¹⁰ says:

The priority of the Chinese in the use of the magnetic compass is now so generally acknowledged that any argument adduced to prove or illustrate it would be altogether

⁶ *Abhandl. zur Geschichte der Math. Wiss. mit Einschluss ihrer Anwendungen, begründet von Moritz Cantor*, No. 30, p. 47, Leipzig, 1912.

⁷ John Milne: *Earthquakes and Other Earth Movements*, London, 1886, p. 14. Milne apparently translated the passage from a Japanese book, and hence the discrepancy in the spelling of the name of the author.

⁸ A. G. McAdie: *The Principles of Aerography*, Chicago, 1917, p. 207; *Japanese Meteorol. Mag.*, 1910, pp. 81-85; *Quart. Journ. Royal Meteorol. Soc.*, Vol. 37, 1911, pp. 83-86.

⁹ Timotheus Bertelli: The Discovery of Magnetic Declination Made by Christopher Columbus, in "Report of the International Meteorological Congress, Held at Chicago, Ill., Aug. 21-24, 1893," *Weather Bur. Bull. No. 11*, Washington, D. C., 1894-96, pp. 486-492.

¹⁰ Alexander Wylie: *Chinese Researches*, Shanghai, 1897, p. 155.

superfluous; the fact that the declination of the magnetic needle was also known to them at an early date is now well understood. In Lih Seang Kaou Ching, which appeared at the end of the seventeenth century (Bk. 4, p. 2), it says, "The magnetic needle cannot be taken as a standard, for it is found to have a declination."

A passage from the life of Yih Hing, a Buddhist priest and imperial astronomer at the commencement of the eighth century, will show that the subject engaged the attention at least 900 years earlier. It is said "On comparing the needle with the north pole he found the former pointed between the constellations of Heu and Wei.¹¹ The pole was just six degrees from Heu, from which the needle declines to the right (east) $2^{\circ} 95'$."¹² Thus at the beginning of the eighth century the variation of the needle at Singan (capital of China at that time) was $2^{\circ} 95'$.¹³

SUN SPOTS

Although the relation between sun spots and weather was not suspected by the Chinese, yet, as pointed out by Hosie,¹⁴ it is generally admitted that the Chinese were the first to discover the sun spots. The famous French astronomer and meteorologist Arago says:¹⁵

Dans les annales de la Chine du père Mailla, on lit qu'en l'an 321 de notre ère, il y avait sur le soleil des taches qui s'apercevaient à la simple vue. En prenant à la lettre les assertions du père Mailla les titres des Chinois seraient de meilleur aloi.

THERMOMETERS AND HYGROSCOPES

Thermometers and hygrosopes were first introduced into China in the middle of the seventeenth century by Ferdinand Verbiest¹⁶ (1623-1688), a disciple of Tycho Brahe (1546-1601). Verbiest entered China in the year 1659. From that year until his death he received numerous favors and honors from the Emperor Kan-Si. For several years he held the post of President of the Board of Mathematics and Astronomy.

The thermometer and the hygroscope, claimed by Verbiest as his own inventions, appear so novel and so different from the early instruments of the West, that it is not out of place to describe them here. In principle Verbiest's thermometer¹⁷ resembles the air thermometer of Galileo and shares the defect of the latter in that it is also affected by the varying atmospheric pressure. As shown in the figure (Fig. 1) the instrument consists of a U-tube made of glass fitted into a wooden frame. One end of the tube is connected with a large bulb filled with air while the other end

¹¹ The constellation Heu commences in Aquarius $19^{\circ} 13' 17''$, and Wei in Aquarius $29^{\circ} 11' 13''$.

¹² In the old Chinese reckoning, a degree is divided into 100 minutes, and a minute into 100 seconds.

¹³ Timotheus Bertelli: *La declinazione magnetica e la sua variazione nelle spazio scoperte da Cristoforo Colombo*, Rome, 1892. He quotes many Chinese passages in French translation to prove that the early Chinese had really no knowledge of the magnetic declination. Apparently Bertelli was not aware of Yih-Hing's work.

¹⁴ Alexander Hosie: *Sunspots and Sun-Shadows Observed in China*, B. C. 28-A. D. 1617, *Journ. North-China Branch Royal Asiatic Soc.*, N. S., Vol. 12, Shanghai, 1878, pp. 91-95.

¹⁵ D. F. J. Arago: *Astronomie populaire*, Vol. 2, pp. 107-108, Paris, 1858.

¹⁶ For further reference to Father Verbiest, see J. B. DuHalde: *The General History of China*, 4 vols., London, 1736 (translated from the French); reference in Vol. 3, pp. 86-110.

¹⁷ Illustrations and descriptions of these two instruments appear in the Chinese Encyclopedia (Kua-Chiang-Tu-Shu Chi-Zung), a work instigated by the emperor Kan-Si (1662-1722) and published during the reign of his successor. A printed edition in 1628 volumes of about 200 pages each was issued at Shanghai in 1889. The illustration of the thermometer is reproduced below (Fig. 1).

is open, water being used to fill the lower portion of the tube. A scale is attached to each arm of the tube, graduated in ten degrees at unequal intervals which vary with the rate of expansion and contraction of the air. As explained by Verbiest, the instrument can be used to measure the atmospheric and ground temperatures, the temperature of the human body, and even the temperature of planets, moon, and stars. He seriously entertained the idea that if the thermometer were exposed to moonlight the gas in the bulb would be seen to contract, showing the low lunar temperature. He also stated that the physical vitality of persons could be tested by their merely rubbing the bulb for a minute or two.

In common with the other hygrosopes of early times, Verbiest's instrument consists of the gut of an animal (a deer in this case), which expands and contracts as the moisture content of air increases or decreases. The deer gut in question is two Chinese feet¹⁸ in length and one-tenth of an inch in thickness. It hangs in a wooden frame open on all sides. At the lower

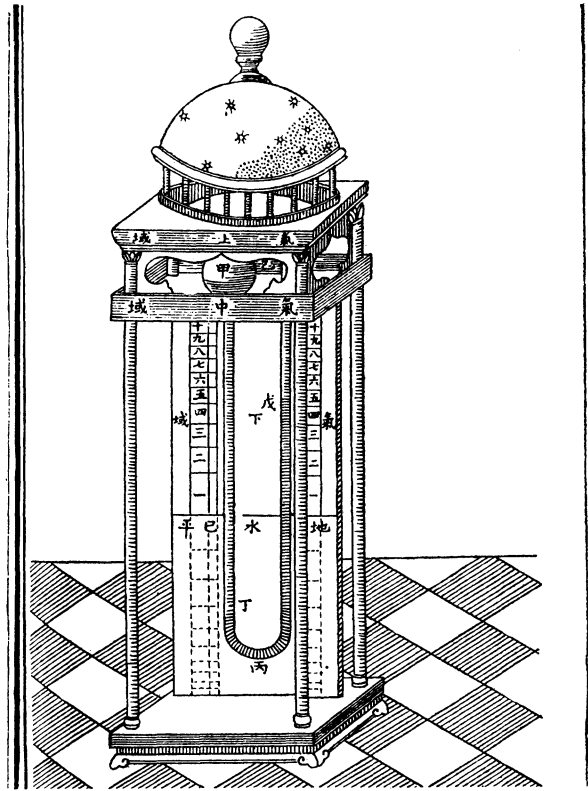


FIG. 1—Ferdinand Verbiest's thermometer of the second half of the seventeenth century. (Reproduced from Fig. 108 of the Chinese Encyclopedia.)

The two columns of figures on the scale are the Chinese numerals from 1 to 10, reading upward. The region below zero is supposed to represent the condition beneath the earth's crust, which, according to Verbiest, is extremely cold. The crown of the instrument with stars engraved on it is supposed to represent the condition in interstellar space, which is thought to be also very cold. The other Chinese characters are used to designate different parts of the instrument.

end of the gut a suitable weight is attached. A little above this an indicator in the form of a needle, decorated with dragons, is inserted in the gut with a scale just beneath it. When the moisture content of the air increases the indicator turns to the left, when it decreases the indicator turns to the right. The relative humidity of the atmosphere is thus roughly indicated.

¹⁸ One Chinese foot = 1.05 English feet.